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Seasonal variation of *Caligus rotundigenitalis* infestation on the host fish *Etroplus suratensis* from the Cochin Backwaters, southwest coast of India

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Abstract

Investigation of four edible fishes (*Etroplus suratensis*, *Oreochromis mossambicus*, *Lates calcarifer*, *Chanos chanos*) collected from a fish landing center along Cochin Backwaters has done for caligid infestation. Of these, caligids were detected only from *Etroplus suratensis* and was identified to be *Caligus rotundigenitalis*. Parasites were attached to the inner side of operculum of host which indicates strong site preference. The annual observation of prevalence, mean intensity and abundance were found to be 19.21%, 1.051 and 0.202 respectively. Variation of prevalence with respect to the different length groups of *E. suratensis* has discussed in this paper. Damages of the inner side of operculum and increase in mucous production were noticed as a result of copepod attachment.

Key words: Caligidae, *Caligus rotundigenitalis*, copepod, crustacean parasites, *Etroplus suratensis*

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1 Introduction

Crustaceans act as the topmost parasites in finfish cultures in various parts of the world (Papapanagiotou et al., 1999; Papapanagiotou and Trilles, 2001; Del Mundo et al., 1996) including India (Rajkumar et al., 2005a, b; Sanil et al., 2009) that result in fish mortalities. *Etroplus suratensis*, *Lates calcarifer*, *Oreochromis mossambicus*, *Chanos chanos* are the popular edible and economically important (Vijayaraghavan et al., 1981; Philipose et al., 2013; Pandey et al., 2014; Jaikumar et al., 2013) fishes of India especially in Kerala, which have high market demand. They have been regarded as a potential species for commercial culturing in various parts of India (Munilkumar et al., 2013; Balkhande, 2019). In many culture systems, fish mortalities have been related to *Caligus* spp. infestation (Yuasa et al., 1998; Costello, 2009; Zafran et al., 2000) which may lead to significant economic losses. Some host fishes have exhibited the disease signs (erosion and haemorrhages on the skin, eyes and fins) and 10% mortality, because of the heavy infestation by *Caligus* species such as *Caligus epidemicus* (Cruz-Lacierda et al., 2011). In other cases, caligids act as the intensifying factor of the existing bacterial infection in the host fishes and enhance the chance of host death (Arriagada et al., 2019). It is either through reducing the survival of infected fish due to the stress induced by sea lice infestation (González et al., 2016) or through increasing the vulnerability of host fish to pathogens, due to the skin lesions produced by copepods (González et al., 2015, 2016). As the parasitic infestation is a major problem to be solved in the marine finfish culturing worldwide, it is very necessary to improve our knowledge about the prevalence of parasitic infestation.

Investigations showed that the parasitic copepods belonging to the family Caligidae have been infested many species of fishes (Lin and Ho, 1993, 2003; Hayward et al., 2008; Jithendran et al., 2008; Hamilton-West et al., 2012; Okawachi et al., 2012; Nagasawa, 2013; Morales-Serna et al., 2014, 2016). *Caligus rotundigenitalis* Yu, 1933 (Caligidae, Siphonostomatoida) has regarded as the most dangerous caligid that infests the pearl spot (Solanki et al., 2016) and other fishes (Ho, 2004). The infestation of *Ca. rotundigenitalis* had resulted in negative effects such as slow growth and mortalities in cultured fishes so that it was also considered as a killer species in Asian aquaculture (Ho, 2000). Hence their monitoring is very important in pearl spot cultures to develop effective prevention and control measures. According to Ho et al. (2000), *Ca. rotundigenitalis* is regarded as a cosmopolitan species and infest a broad range of hosts. This is the most common species in cultured marine fish (Muhd-Faizul et al., 2012) and wild fish (Ho et al., 2004) in East Asia. However, the literature on *Ca. rotundigenitalis* those including its prevalence are very limited from India (Pillai, 1985; Solanki et al., 2016; Vinoth et al., 2010). In this context, we report the prevalence, mean intensity, and abundance of *Ca. rotundigenitalis* on the pearl spot, *Etroplus suratensis* that collected from a fish landing center along Cochin Backwaters from the southwest coast of India.

2 Materials and methods

The study area, Munambam Harbour (10°10′N, 76°10′E), is a major fish landing center situated at the side of the Cochin Backwaters in Kerala State along the southwest coast of India (Dinesh Kumar et al., 2009). Fish samples were collected from Munambam Harbour and monthly sampling of four edible fishes from four different families: *E. suratensis* (Cichlidae), *O. mossambicus* (Cichlidae), *L. calcarifer* (Latidae), *Ch. chanos* (Chanidae) for caligid copepod parasitisation carried out from January to Decem-

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ber 2018. Copepods were removed with forceps, after the thorough checking of fish samples. Fishes were identified (Froese and Pauly, 2018) and their lengths were measured with meter rule. Some damages on the operculum have detected where the copepods were attached. Parasites were preserved in 70% ethanol for further analyses. The identification of copepod specimens was done by using the descriptions of Pillai (1985). Sampling months were grouped into three seasons, viz., monsoon (June–September), postmonsoon (October–January) and premonsoon (February–May), to explain the seasonal differences. The prevalence infestation (number of infested fishes/number of observed fish×100), mean intensity (number of particular parasitic copepod species collected/number of infested fish) and abundance (number of particular parasitic copepod species collected/number of observed fish) in different seasons were evaluated (Margolis et al., 1982; Bush et al., 1997). Variation of prevalence with respect to the lengths of the fishes was also calculated by the same procedure. ANOVA was performed to compare the seasonal differences in prevalence, mean intensity and abundance. The graphs were constructed using Microsoft Excel spread sheet version 2007.

3 Results and discussion

Although the presence of parasitic copepods has been detected on *Etroplus suratensis* and *Lates calcarifer* during the study period, the *Caligus* sp. was found only on *E. suratensis* (Table 1). Only a very small number of Lernanthropid copepods were recovered from *L. calcarifer*. Altogether 203 captured specimens of *E. suratensis* were examined during January to December 2018 and the infestation of parasitic copepod *Ca. rotundigenitalis* (Caligidae) was recorded in present study (Table 1). Generally they are attached to the gill filaments, body surface, and inner operculum of the fishes. In this study, we have observed that the parasites were attached to the left and right inner operculum of pearl spot throughout the investigation period. This indirectly disclosed the preference for the infestation site of *Ca. rotundigenitalis* which has been previously reported by Yuniar et al. (2007) and Leaw et al. (2012).

The recovered specimens of *Ca. rotundigenitalis* were distinguished (Pillai, 1985) by a sub-circular cephalothorax shield, 2-segmented abdomen, genital complex wider than long, slightly ovate and bulged. Most of the specimens of *Ca. rotundigenitalis* (except three for males) were females with the egg sacs in the present study. Occurrence of *Ca. rotundigenitalis* has been recorded from South Africa (Grobler, 2004), India, Malaysia, Philippines (Rangnekar, 1959; Pillai, 1985; Maran et al., 2009, 2016; Kua and Muhd-Faizul, 2010). Recently, Vinoth et al. (2010) and Solanki et al. (2016) have added information about this species from Indian waters in *Mugil cephalus* and *Etroplus suratensis.* Presence of this species has previously recorded from South Kerala (Pillai and Natarajan, 1977) on *Gnathanodon speciosus*, *Lutjanus malabaricus* and *Scatophagus argus*; from North Malabar on *Caranx ignobilis*, *Etroplus suratensis* and *Scatophagus argus* (Nikhila et al., 2019) without other information in detail. Nikhila et al. (2019) has also reported its presence on *Mugil cephalus* from Kalamukku fish landing center along Cochin Backwaters; no other information about prevalence of infestation, mean intensity and abundance were available.

Overall prevalence, mean intensity, and abundance at different seasons were found to be 19.21%, 1.051 and 0.202 respectively. However, most of the literature related to *Ca. rotundigenitalis* has not highlighted the prevalence, mean intensity with respect to the seasons and the damages caused by this species on the host. Previously, prevalence and mean intensity of *Ca. rotundigenitalis* has been documented during pre-southwest monsoon by Leaw et al. (2012) on *Lutjanus erythropterus* in Malaysia as 81.4 and 5.6% respectively and by Yuniar et al. (2007) on *Mugil cephalus* in Indonesia as 24.3 and 2.3% respectively. Vinoth et al. (2010) also recorded 10% of prevalence of infestation on *Mugil cephalus* along southeast coast of India. In the present study, maximum prevalence of infestation was observed in pre-monsoon followed by post-southwest monsoon (Fig. 1). Seasonal differences of the prevalence of infestation is significant (ANOVA, $P<0.05$). In this study, higher abundance (0.4) was observed during April and December (Fig. 1); while mean intensity (Fig. 2) was comparatively high in March (1.17) followed by December (1.14). Investigations of Muhd-Faizul et al. (2012) revealed that *Ca. rotundigenitalis* would tolerate only a narrow salinity range (25–28) and even a low percentage of this species would be able to produce a challenge for the commercial culturing of fishes due to their capacity to make infestation. The highest prevalence of infestation was noted to be 23.86% relating to the different length groups of the host fish, *E. suratensis* (Table 2). Prevalence of *Ca.*

Table 1. Monthly variation in the observed host fish, *Etroplus suratensis*, that collected from Munambam Harbour during 2018

Months	Number of the host fishes observed	Number of the host fishes infested
January	18	0
February	16	4
March	18	6
April	22	9
May	18	3
June	14	3
July	13	1
August	20	3
September	16	0
October	15	0
November	13	3
December	20	7
Total	203	39

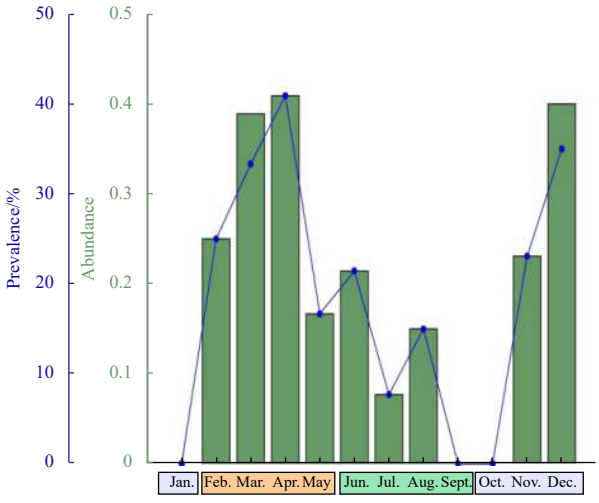

Fig. 1. Prevalence and abundance of *Caligus rotundigenitalis* on *Etroplus suratensis* from Munambam Harbour during 2018 in different seasons, ie. premonsoon (February–May), nonsoon (June–September), post monsoon (October–January of next year).

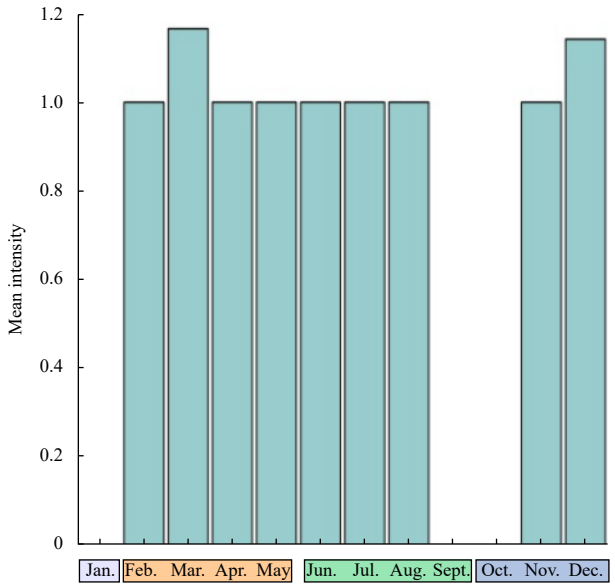

Fig. 2. Mean intensity of *Caligus rotundigenitalis* on *Etroplus suratensis* from Munambam Harbour during 2018 in different seasons, ie. premonsoon (February–May), monsoon (June–September), post monsoon (October–January).

Table 2. Prevalence of *Caligus rotundigenitalis* versus different length groups of host fish (*Etroplus suratensis*) at Munambam fishing harbour

Length groups of fishes/cm	Number of the observed fishes	Number of the infested fishes	Prevalence of infestation under different fish length groups/%
12–15.5	27	5	18.52
16–19.5	60	7	11.67
20–23.5	88	21	23.86
24–27.5	28	6	21.43

rotundigenitalis infestation with respect to the fish length on another host (*Lutjanus erythropterus*) was analysed by Leaw et al. (2012). In the present study maximum prevalence was noticed in the host having the length range of 20.0–23.5 cm and the least prevalence in the host having the range of 16–19.5 cm in length (Table 2).

Substantial information on the harmful effects on fishes by caligids has been documented by Johnson et al. Symptoms of many diseases were studied in host fishes due to *Caligus* sp. (Noor El-Deen et al., 2012). In the case of severe infestations, disease outbreaks caused by *Ca. flexispina* (González et al., 2000), *C. minimus* (Pavoletti et al., 1999) and *Ca. rotundigenitalis* (Ho, 2000) has been reported. Lesion on the epithelium of operculum (inner surface) was noticed due to the strong attachment and the feeding of copepods in the present study. None of the previous studies reported the damages on the operculum of host fishes by *Ca. rotundigenitalis*. Presence of large quantity of mucous production at the site of attachment indicated the response of tissue against the parasite infestation. Even the presence of one parasite (*Ca. rotundigenitalis*) also triggered the mucous secretion from the attachment position and the copepod itself has seen as covered by the mucous during observation. More than half of the infested fishes showed a similar response during the parasite examination in our study. A similar situation of increase in mucous secretion following the attachment of parasitic copepod on affected fishes has been described by Fast et al. (2002) and González et al. (2016). Opercular lesions in host fish caused by *Ca. rotundigenitalis* may act as the location for bacterial adhesions as suggested by Tully and Nolan (2002). Microbial analysis to verify the presence of bacterial pathogens at the attachment site of copepod has not done in the present study. Only physical damages (lesion and increase in mucous production) due to the attachment of copepods were noticed in our study.

Recently, Khoa et al. (2019) reported the advantage of neem oil (which is an eco-friendly substance) for controlling *C. rotundigenitalis* on Malaysia at the specific concentration on the host fish *L. calcarifer*. However, the basic information on the seasonal variations in the prevalence of each particular parasitic copepod species is very essential factor for the effective use of anti-parasitic drugs or substances (such as neem oil) at exact concentration; for controlling the caligid copepods with no risks for the host fishes in different environments. Our study confirmed the presence of *Ca. rotundigenitalis* only on pearl spot, *E. suratensis* revealed that the prevalence of this parasite becomes higher during pre-southwest monsoon. It was found that this copepod species has preferential infestation towards the particular length of the host fish. Since the copepods recovered from pearl spot is denoted by *Ca. rotundigenitalis* and they cause damages to the host fish due to their attachment and feeding, an inclusive study on the parasitic copepods is required along this coastal area for making the effective controlling measures to prevent secondary microbial infection in pearl spot.

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